

I claim:

1. A nozzle type device with an integral pump, where the nozzle type device is adapted to atomize liquids at a nozzle tip surface by capillary waves generated in a liquid layer thereon by application of a frequency above about 200 kHz in transducers  
5 attached distal to the nozzle tip comprising:
  - (a) two or more horn stages, each having a central channel defined within a body of the horn stage extending from a base and a horn tip, each horn stage being further adapted to have a length of about one half of the acoustic wavelength at the frequency;
  - (b) a driver section of about one half of the acoustic wavelength at the frequency with  
10 the transducers rigidly attached therein and having a central channel defined within a body of the driver stage extending from a forward end to a rearward end;
  - (c) a forward horn stage section comprising one or more sequentially connected forward horn stages, with a first base of a first forward horn stage integral with the forward end; and
  - 15 (d) a pump horn stage section comprising one or more sequentially connected pump horn stages, with a first base of a first pump horn stage integral with the rearward end;
  - (e) the central channels of all the horn stages and the driver section form a continuous channel extending from an inlet opening defined in a free end of the pump horn stage section to an outlet opening defined in a free end of the forward horn stage  
20 section.
2. The device of claim 1 wherein the horn stages are Fourier horns.
3. The device of claim 1 wherein the forward horn stage section comprises at least  
25 three horn stages.
4. The device of claim 1 wherein the pump horn stage section comprises at least two horn stages.
- 30 5. The device of claim 1 wherein a cross section shape of the horn stages is conical.

6. The device of claim 1 wherein a cross section shape of the horn stages is rectangular.

5        7. The device of claim 6 wherein the horn stages are comprised of two planar halves formed by silicon wafer manufacturing and joined to define the central channel.

8. The device of claim 1 wherein a cross section shape of the central channel is oval, square, rectangular, diamond, or circular.

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9. The device of claim 1 wherein the horn stages comprise substantially only silicon, silica compounds or silica composites.

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